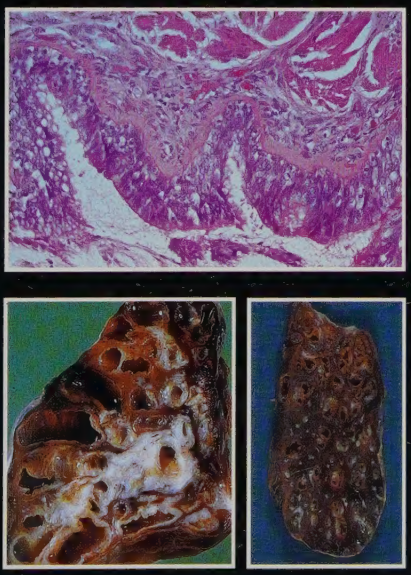
Color Atlas of Respiratory Disease



Volume 2 of 4

Color Atlas of Respiratory Disease

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GP Greenwich Press
Greenwich Connecticut

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Greenwich Press
Greenwich Office Park #6
Greenwich, CT 06830

ISBN: 157013–038–8

Printed in Hong Kong

Introduction

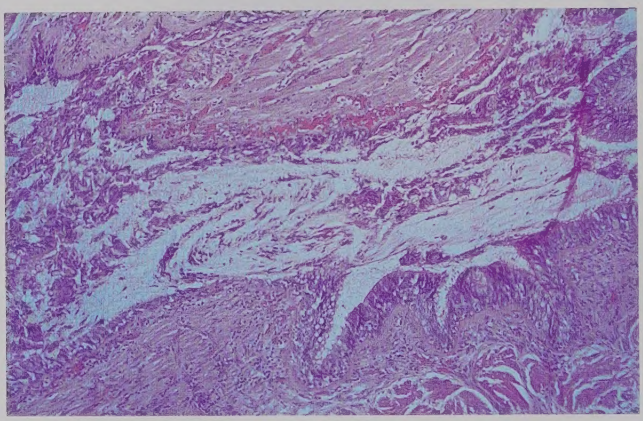
Respiratory disorders represent a diverse group of diseases that pose a diagnostic challenge for the clinician. The *Color Atlas of Respiratory Disease,* a four-volume atlas, includes images of direct or indirect visualization of the respiratory tract. Radiographs, computed tomography and magnetic resonance imaging, and bronchoscopy views, as well as cytology and biopsy slides and ECG tracings, are presented to assist the clinician in making a diagnosis.

A wide variety of pulmonary disorders are included within the four volumes: Volume 1, diseases of the upper respiratory tract and pulmonary vascular disease; Volume 2, airway diseases; Volume 3, respiratory tract infections; and Volume 4, parenchymal and pleural disorders. Different presentations of the disorder and/or its progression are shown. The captions describe the image and its interpretation rather than the disease and its etiology and management.

Volume 2 focuses on the diseases of the airways, including asthma, aspiration, cystic fibrosis, emphysema, and bronchitis. It is hoped that this atlas will prove valuable to you in your practice of clinical medicine.

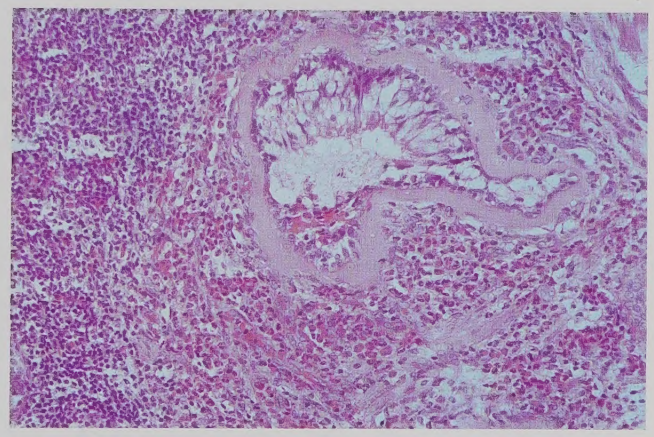
Airway
Diseases

Asthma



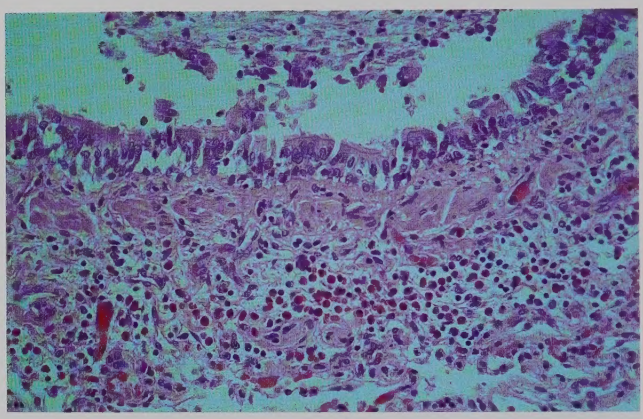
1

1 ♦ Bronchus from a patient with fatal asthma. There is an extensive infiltration of inflammatory cells, predominantly mononuclear cells and eosinophils. There is marked smooth muscle contraction and hypertrophy that reduces the size of the airway. This is further complicated by luminal obstruction of the bronchus with a mucous plug. The chronic nature of the condition is reflected in the markedly thickened eosinophilic basement membrane due to immunoglobulin deposits and the reaction of basement membrane to the deposits.



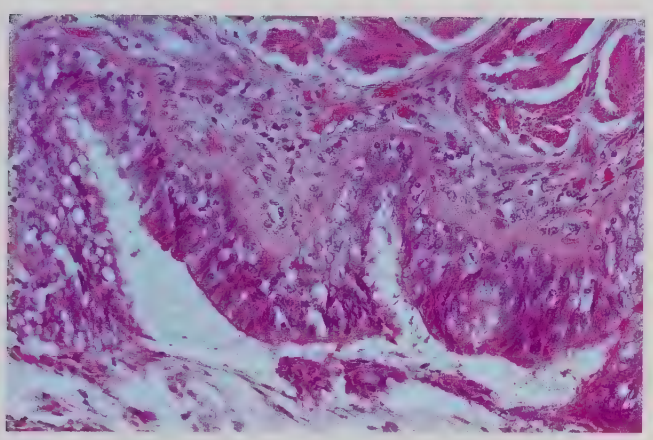
2

2 ♦ The small bronchus in 2 demonstrates the intense inflammatory infiltrate composed primarily of eosinophils that occurs with asthma. There is typically an admixture of mast cells and lymphocytes as well.



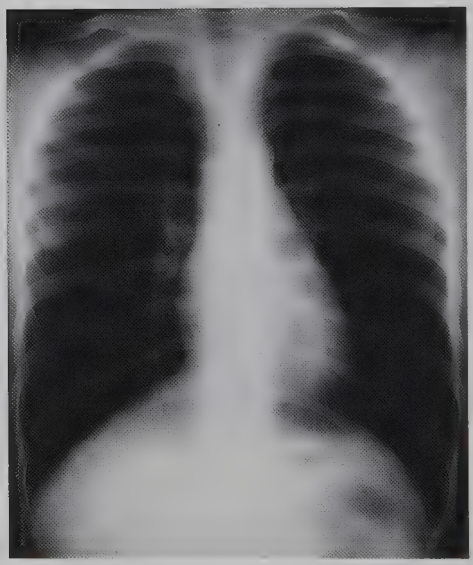
3

3 ♦ The bronchial epithelium has a goblet-cell hyperplasia leading to increased mucous secretion. Congestion and edema further narrow the airways making the mucus harder to clear.



4

4 ♦ The combination of increased mucus, desquamated bronchial cells, eosinophils, and other debris leads to the formation of a mucous plug or cast. These casts are also known as Curschmann spirals. Bright red, needlelike crystals—Charcot-Leyden crystals—that result from the accretion of debris from eosinophils, may also be present in the bronchial lumen.

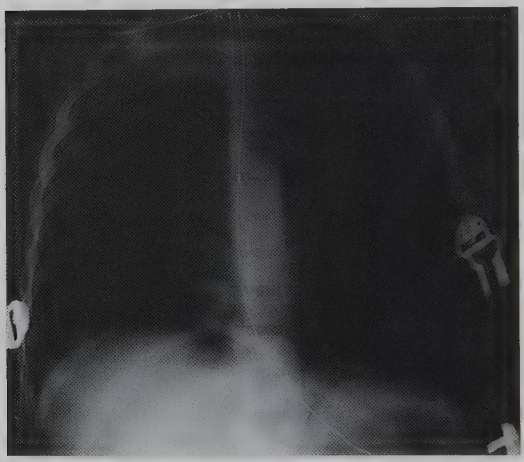


5

5 ♦ Acute bronchospastic episodes of asthma lead to airway obstruction, which manifests as hyperinflation on chest radiograph.

6

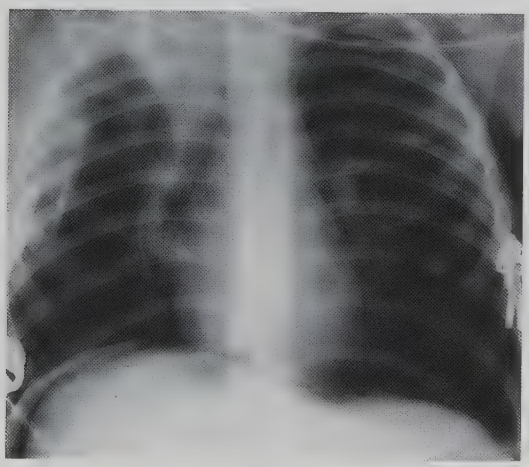
6 ♦ Lateral view of patient in 5 shows increased anterior-posterior diameter and flattening of the diaphragm.



7

7-8 ♦ When superimposed on hyperinflation, the shearing forces that occur during an acute, severe asthma episode can cause air to rupture the alveolar walls and to dissect along blood vessel sheaths to the mediastinum. This is a serious complication and indicates a worsening clinical course. Air can also dissect into the superficial soft tissue of the neck and axillae. Subcutaneous emphysema is usually a late sign of extrapleural air.

9 ♦ A mucous plug of one of the major bronchi. It leads to either total collapse of a lobe, as in 10 and 11, or to a patchy atelectasis, as in 12 and 13.



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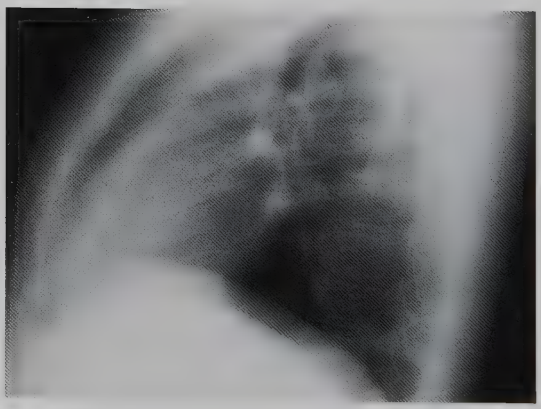

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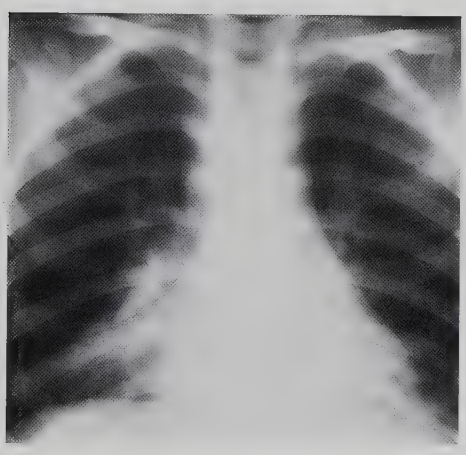
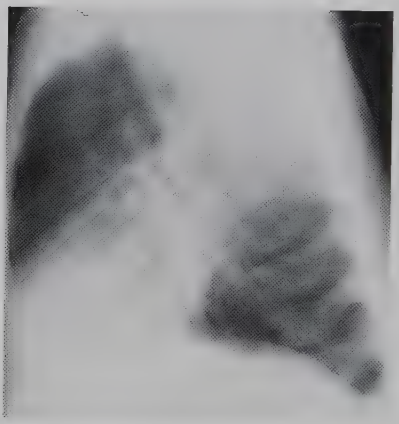


12

10-11 ♦ Complete collapse of the right upper lobe as a result of mucous plugging leads to decreased air volume on the right side. In addition, on the lateral view, "pancaking" of the right upper lobe is seen as a thin line paralleling the sternum.

12 ♦ Recurrent pneumonia can be a presenting sign of asthma. It usually involves the right middle lobe. Patients have cough and a recurrence of fever that seem to show variable response to antibiotics.



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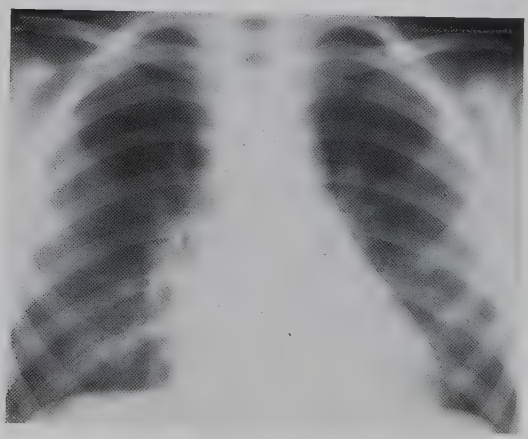

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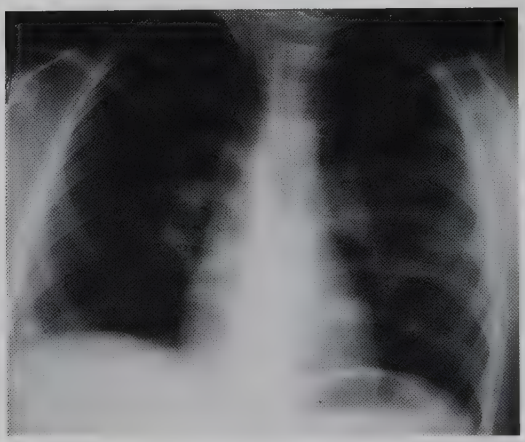
15

13 ♦ Lateral view of patient in 12.

14 ♦ Aggressive treatment with asthma medications can lead to complete resolution of symptoms and clearing of the pneumonia.

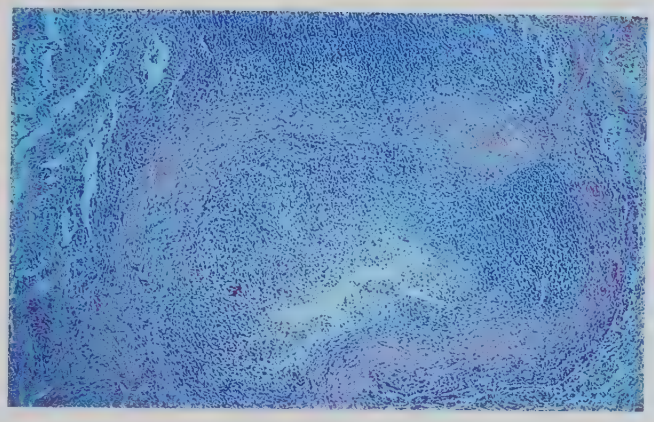
15 ♦ Chronic cough that seems to be dry and hacking and worse at night can be the sole manifestation of asthma. The cough can be so severe as to cause conjunctival bleeding.



16

16 ♦ Radiographic findings of bronchocentric granulomatosis are compatible with interstitial infiltrates, usually involving the lower lobes.

17-18 ♦ Microscopically, most of the inflammation of bronchocentric granulomatosis begins in the distal bronchioles. Although the destruction may extend somewhat into the surrounding lung, the peribronchiolar distribution of the changes remains constant. A palisade of epithelioid histiocytes surround the lumen of the bronchioles. Later in the progression of the reaction (18), both the mucosa and the wall of the bronchioles are totally destroyed by the granulomatosis reaction. Since this reaction occurs around the center of the bronchiole, it has been termed "bronchocentric." Eosinophils mixed with plasma cells, lymphocytes, histiocytes, and occasional multinucleated giant cells form the surrounding area.



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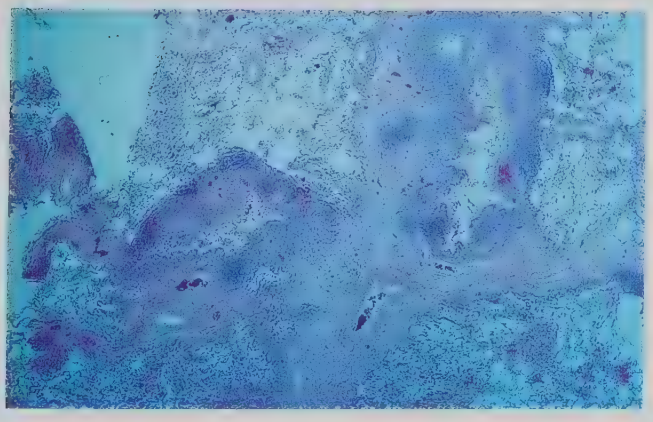


18

Clinical Pearls

1 ♦ Inflammation is present even in the mild form of asthma.

2 ♦ Asthmatic inflammation is linked to the late-phase asthmatic response and to airway hyperresponsiveness.

3 ♦ The "3 Cs" of asthma mucus include:
- a) Curschmann's spirals—mucous strands
- b) Charcot-Leyden crystals—desquamative eosinophils
- c) creola bodies—desquamative epithelial cells.

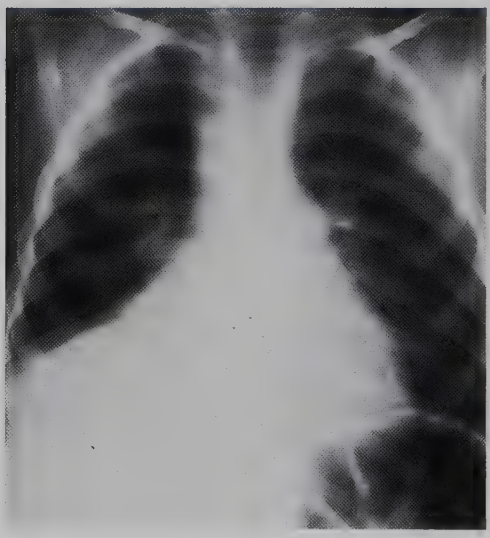
4 ♦ Air trapping and hyperinflation are common findings in acute asthma.

5 ♦ Pneumomediastinum in asthma indicates a worsening clinical course.

6 ♦ Recurrent pneumonia may be a presenting sign of asthma.

Suggested Readings

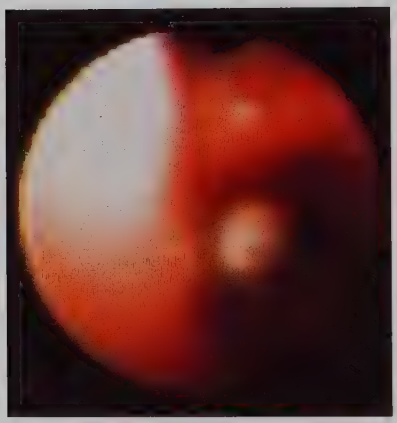
1. NHLBI/WHO Workshop Report; 1995. Global Strategy for Asthma Management and Prevention. National Institutes of Health Publication. No.95;95-3659; 1995.
2. Reisman JJ, Candy GJ, Levison H. Approach to chronic cough in childhood. *Ann Allergy.* 1988;61:163-169.
3. Eigen H, Laughlin JJ, Homrighausen J. Recurrent pneumonia in children and its relationship to bronchial hyperreactivity. *Pediatrics.* 1982;70:698-704.
4. Richards GN, Kolbe J, Fenwick JL. Demographic characteristics of patients with severe life-threatening asthma: comparison with asthma death. *Thorax.* 1993;48:1105-1109.



19

20

19-20 ♦ Most aspirated foreign objects are usually small enough to lodge in a major airway such as a mainstem or a lobar bronchus. Most of the foreign bodies aspirated are radiolucent and, therefore, not visible on chest radiographs. The main results of foreign body aspiration are obstructive emphysema and, at the later stage, obstructive atelectasis. On occasion, either total atelectasis of the lungs or total atelectasis of one or two lobes can occur. In this case, there is total pulmonary consolidation of the right middle and right lower lobes.



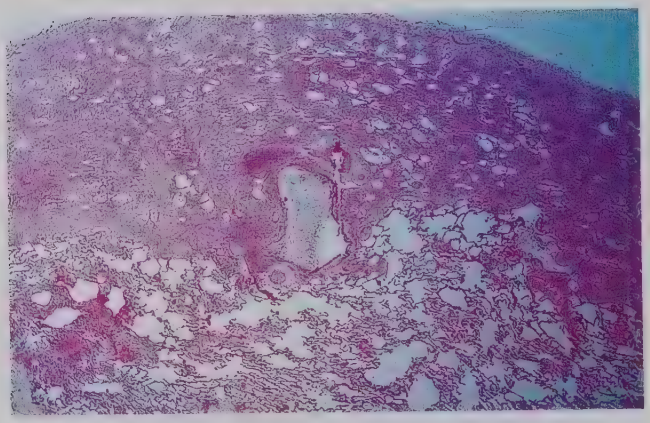
21

22

23

21 ♦ This case shows a popcorn kernel in the bronchus intermedius in the child depicted in 19–20. The most common types of foreign bodies aspirated by children include peanuts or other nuts (48%), seed husk beans (20%), plastic toys (6%), carrots, apples, or potatoes (5%), and popcorn (3%).

22-23 ♦ Chest radiograph after the removal of the foreign body seen in 21.



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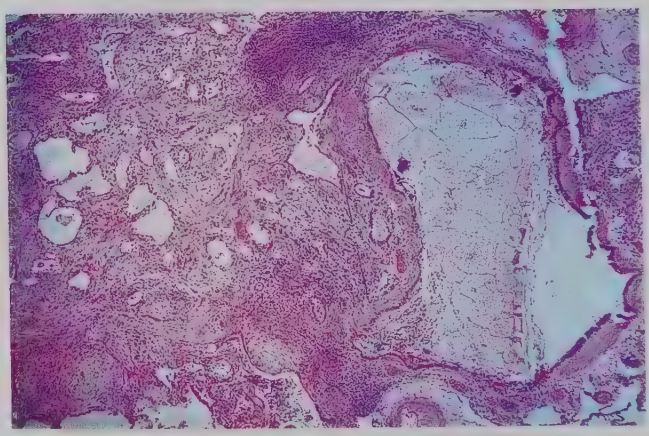

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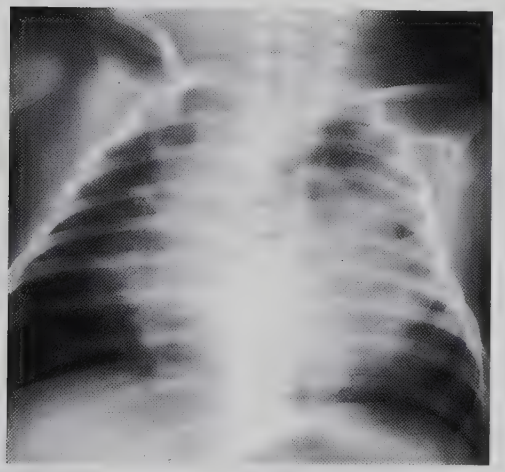
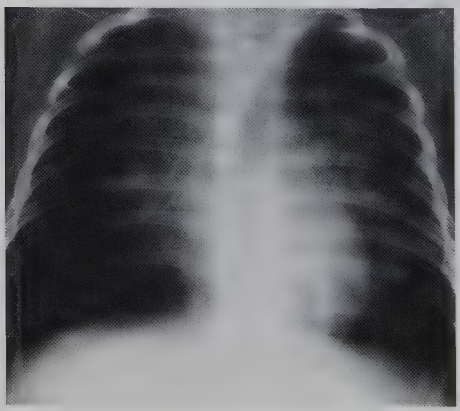


26

24-25 ♦ Microscopic examination (24) of a bronchiole with fibrosis distal to the foreign body. A wedge-shaped area of peripheral fibrosis is seen at low power. Higher magnification (25) reveals the presence of an obstructive foreign body (vegetable matter) in the bronchioles supplying the area of fibrosis.

26 ♦ Aspiration of mineral oil resulting in lipoid pneumonia in a 9-week-old infant. Lipoid pneumonia occurs when oil- or fat-containing substances are aspirated into the lungs. The radiographic findings are consistent with a central dense alveolar infiltrate compatible with aspiration pneumonia.

27



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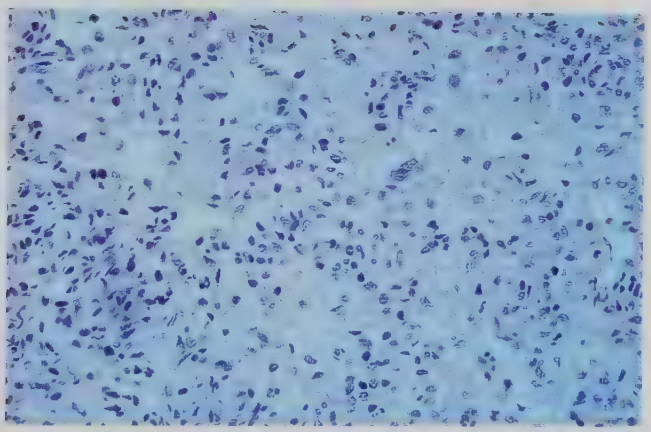
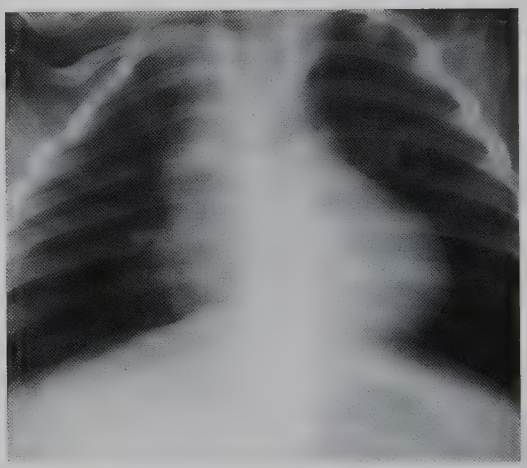


29

27-28 ♦ Lipoid pneumonia that developed in the patient in 26 over several months and included hyperinflation and progressive centropulmonary infiltrate.

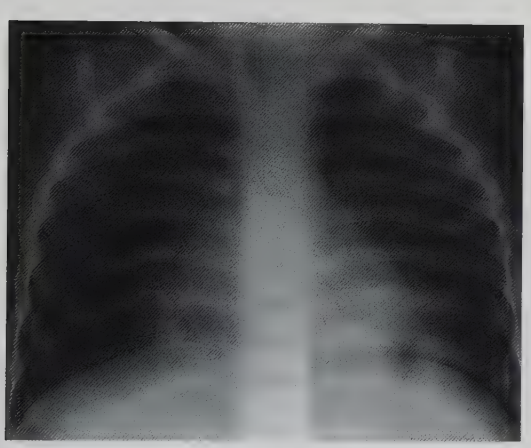
29 ♦ Histology of lipoid pneumonia. Thoracoscopic lung biopsy of patient in 26–28 revealed numerous lipid-laden (vacuolated) macrophages within the alveoli.



30

30 ♦ With corticosteroid therapy, the chest findings in 26–29 showed considerable improvement in the dense infiltrate; however, the hyperinflation remained present until a few months later when the lung returned to normal.

31-32 ♦ Chest radiographic findings due to hydrocarbon aspiration include patchy bibasilar infiltrate that appears soon after aspiration. Within 7 to 10 days after aspiration, bleb formation or pneumatocele appears. Pneumatoceles tend to resolve spontaneously with time, without complications in the majority of cases.



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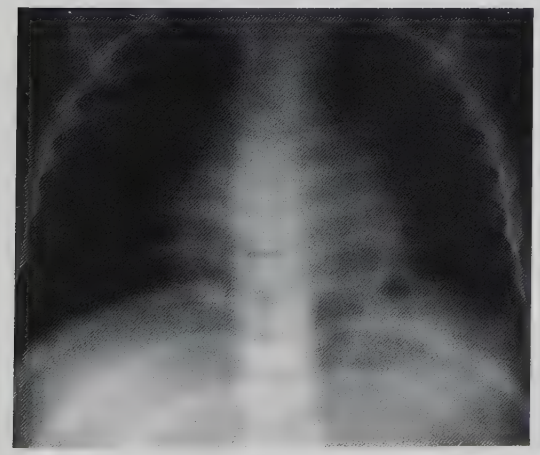

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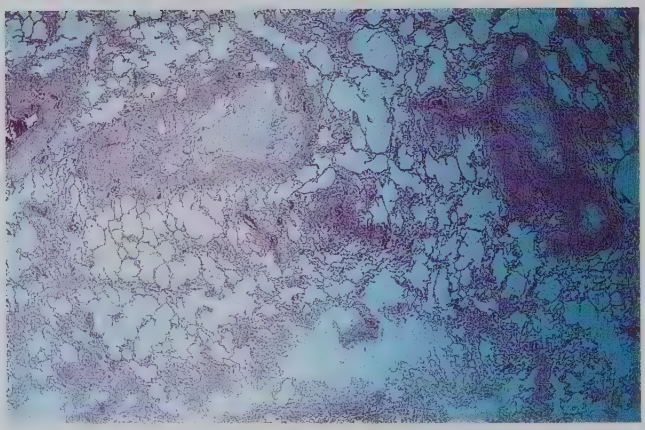
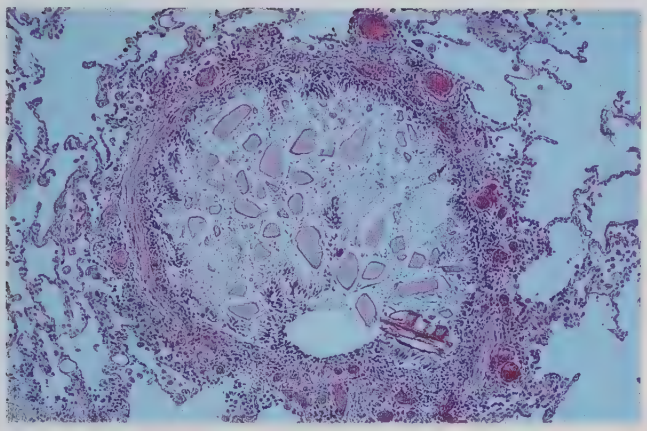


33

33 ♦ Histology from the autopsy of a patient who aspirated gastric contents. Low magnification demonstrates obstructive emphysema secondary to occlusion of bronchioles.



34

34 ♦ High magnification of specimen in 33 demonstrates numerous partially digested food particles occluding the bronchiole.

Clinical Pearls

1 ♦ Aspiration of foreign material is a common hazard in infancy and childhood.

2 ♦ Many products have been implicated in the pathogenesis of lipoid pneumonia: mineral oil; rendered animal fat; and cleaning, cosmetic, and automotive products.

3 ♦ Most of the aspirated foreign bodies are usually not seen on routine chest radiograph.

4 ♦ Recurrent pulmonary infiltrates may be the only clue to foreign body aspiration.

5 ♦ Pneumatocele formation is a late manifestation of hydrocarbon aspiration.

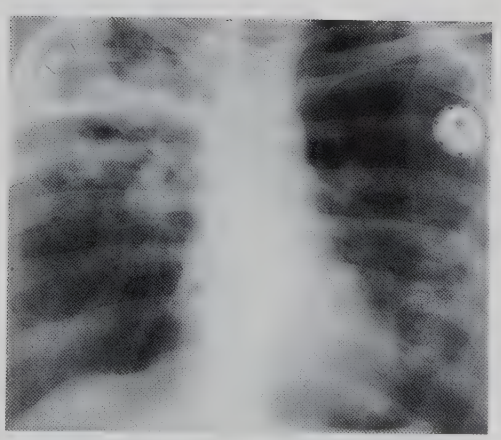
Suggested Readings

1. Macke JD. Acute lung injury. In: Loughlin AM, Eigen H, eds. *Respiratory Disease in Children: Diagnosis and Management.* Baltimore, Md: Williams & Wilkins; 1994.
2. Baker SP, Fisher RS. Childhood asphyxiation by choking or suffocation. *JAMA.* 1980;244:1343-1346.
3. Hugosson CO, Riff EJ, Moore CC, Akhtar M, Tufenkeji HT. Lipoid pneumonia in infants: a radiological-pathological study. *Pediatr Radiol.* 1991;21(3):193-197.
4. Lo Cicero J III. Bronchopulmonary aspiration. *Surg Clin North Am.* 1989;69:71.

35

35 ♦ Pulmonary symptoms of cystic fibrosis (CF) include chronic cough, recurrent pneumonia, recurrent wheezing, dyspnea, retractions, atelectasis, and bronchiectasis. Airway infection, together with airway obstruction due to mucous secretion and plugging, leads to progressive air trapping with an increase in the posterior-anterior diameter of the chest. The pigeon- or barrel-chest deformity is a sign of advanced disease.

36-37 ♦ With the progression of cystic fibrosis, which may be seen radiologically, there are extensive peribronchial and parenchymal changes. There are also advanced changes of bronchiectasis scattered throughout the lung, but more prominent in the upper lobes. At this advanced stage, bilateral diffuse cystic interstitial lung disease is also seen with honeycombing throughout the lung.



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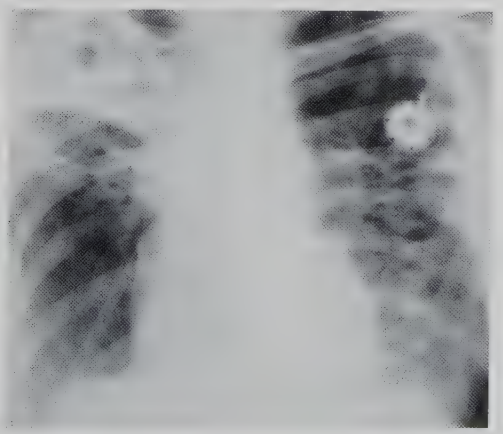

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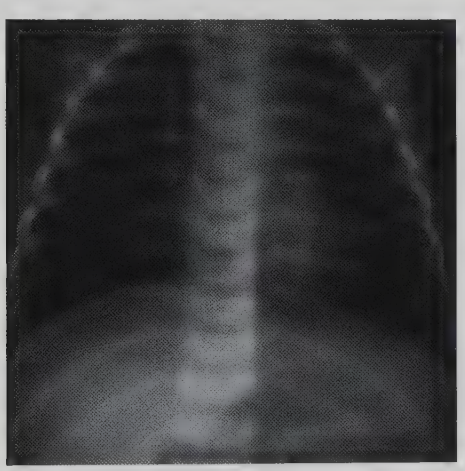
38

38 ♦ Digital clubbing is often a prominent manifestation of advanced lung disease in cystic fibrosis. The thickness of the fingertip increases, and the angle at which the nail meets the finger flattens.

39-43 ♦ At birth the radiograph is usually normal (39). The earliest radiographic manifestation of cystic fibrosis may be only hyperinflation produced by mucous plugging of the distal airway. The hyperinflation manifests itself by an increased anterior-posterior chest diameter, widened intercostal space, and flattened diaphragm.

40 ♦ As bronchitis develops from a bacterial infection, the chest radiographic finding changes to thick-walled circles, seen as increased bronchopulmonary markings. Bronchiectasis develops in all patients and is usually generalized but seems to be worse in the upper lobes.



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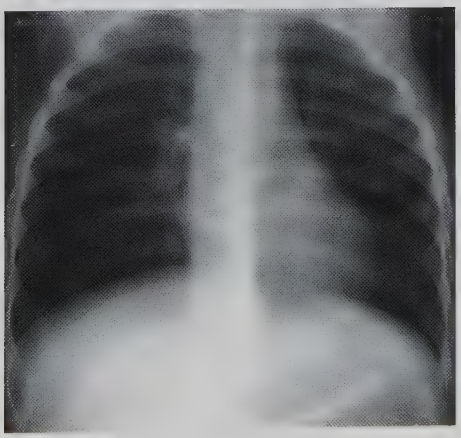


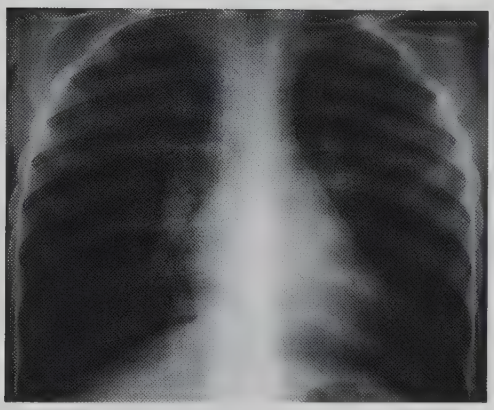
40

41

41 ♦ Mucous impaction and bronchiectasis usually produce "fingerlike" projections radiating from the hila.

42 ♦ As cystic fibrosis advances, peripherally rounded lesions 0.5 cm or less in size, which represent microabscesses and mucopurulent secretions, become evident.

43 ♦ With end stage disease, obstructive emphysema, microabscesses, fibrosis, bronchiectasis, and, occasionally, subpleural bleb or localized pneumothoraces are seen.



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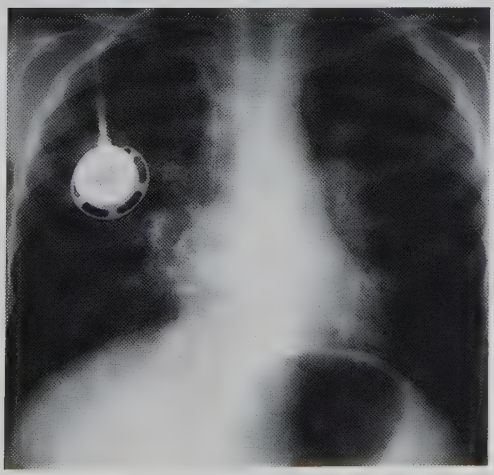

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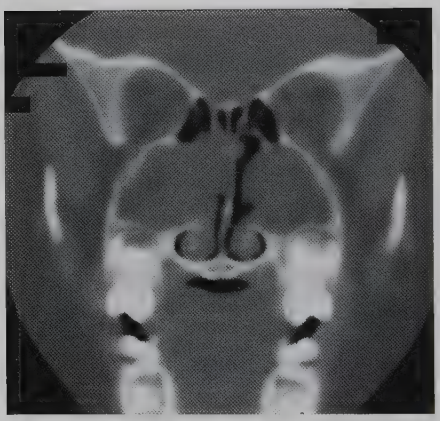


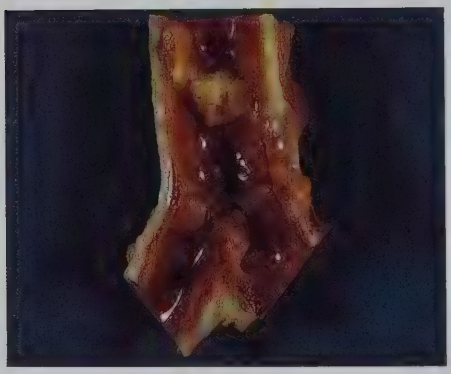
44

44 ♦ Nearly all patients with cystic fibrosis (CF) have retained secretions in their sinuses, giving a picture of chronic sinusitis on computed tomography scan. In addition, 15% to 20% of patients will have nasal polyps. Radiographic findings of pansinusitis and nasal polyposis can provide a clue to the diagnosis of CF. Involvement of the sinuses may be extensive, as in this patient, where bilateral maxillary opacifications are almost complete. In addition, the median wall of both maxillary sinus opacifications can become very thin and displaced medially under the pressure of the retained thick material.

45-46 ♦ Grossly, in cystic fibrosis, the lungs are often very large and hyperinflated. Bronchiectasis results from repeated infections and airway obstruction. Large abscess cavities are also evident.

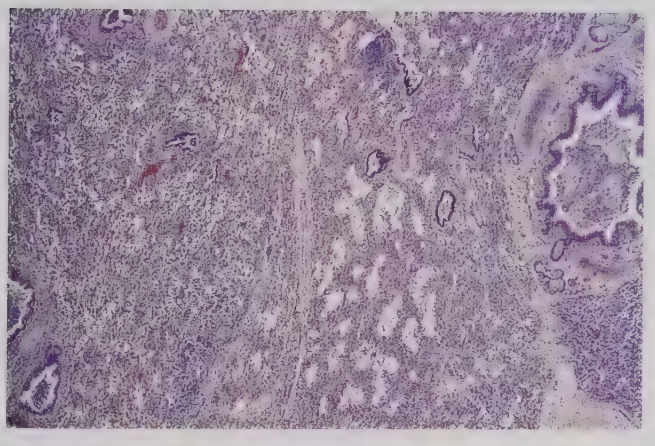
45

46



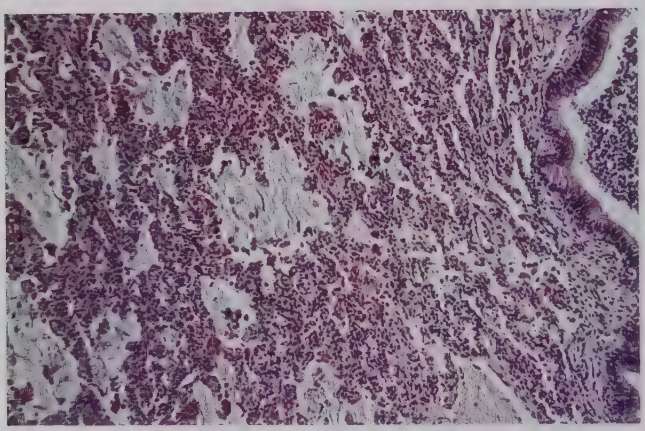
47

47 ♦ Tracheal lumen from autopsy of a patient with cystic fibrosis contains a large mucous plug. Mucosa is also inflamed and edematous, leading to further narrowing of the lumen.



48

48 ♦ The lungs of this infant already demonstrate both atelectasis and occlusion of the distal airways as well as the bronchioles. In the center, the centrilobular segment of the acinus is plugged with mucus, and the peripheral alveoli are collapsed. Across a septum, the lung demonstrates panlobular atelectasis. A large bronchus is filled with mucus and cellular debris.



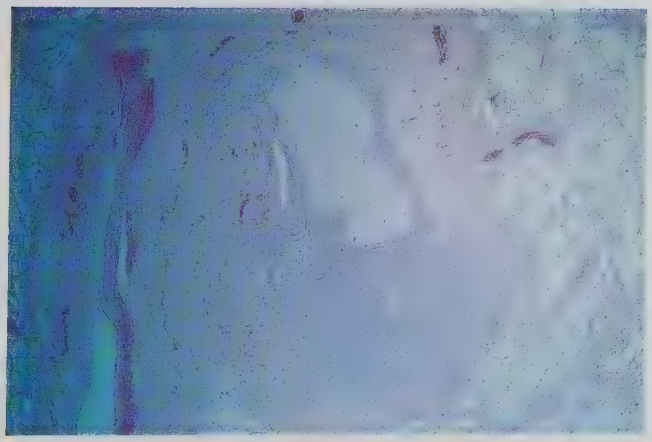
49

49 ♦ Alveolar ducts and alveoli filled with thick mucus. Interstitial tissue contains an acute inflammatory infiltrate. The bronchiole also contains a mucous plug with a marked acute inflammatory infiltrate.

50 ♦ Tracheal lumen filled with mucus and a marked acute inflammatory infiltrate. Note that the tracheal mucous glands are markedly dilated.

51 ♦ Numerous microabscesses form in the lungs of cystic fibrosis patients. The abscess in the center demonstrates loss of lung landmarks. It is surrounded by aerated lung. An amorphous mass adjacent to the abscess is a mucous plug.

50



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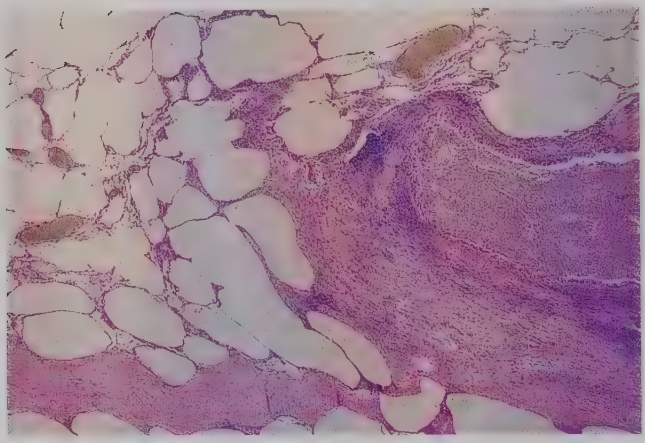

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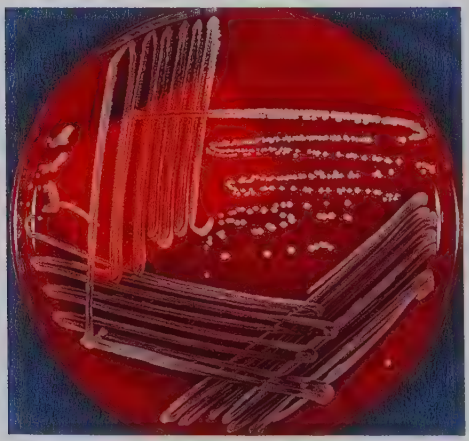

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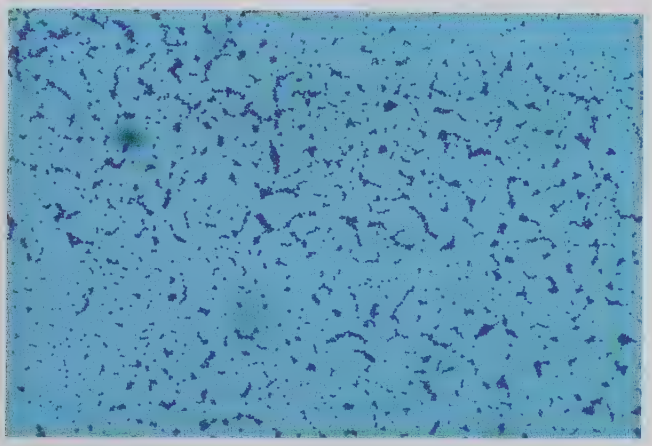
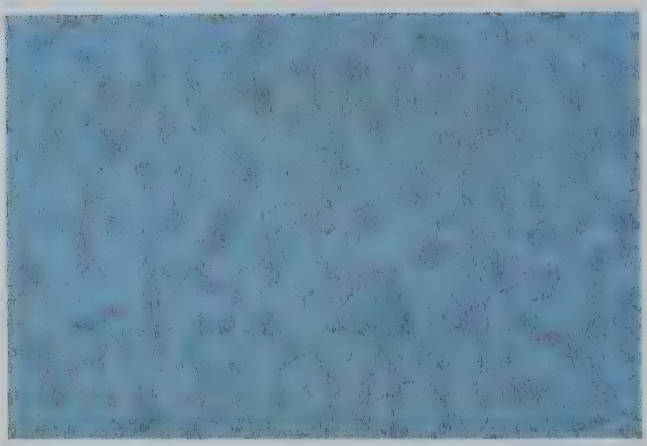


54

52 ♦ Repeated infections and obstruction lead to parenchymal destruction with subsequent scarring and fibrosis.

53 ♦ Microbiologic culture of *Staphylococcus aureus.* The lower airways of patients with cystic fibrosis (CF) are colonized at an early age with bacteria. The most common bacteria are *S aureus* and *Haemophilus influenzae* in patients younger than 1 year of age. In older children, over 65% of CF patients colonized with *Pseudomonas aeruginosa*, 30% with *S aureus*, and the remainder with *H influenzae* and other Gram-negative bacteria.

54 ♦ Gram's stain showing numerous Gram-positive cocci consistent with *Staphylococcus aureus.*



55

55 ♦ Gram's stain showing numerous Gram-negative rods consistent with *Pseudomonas aeruginosa.*

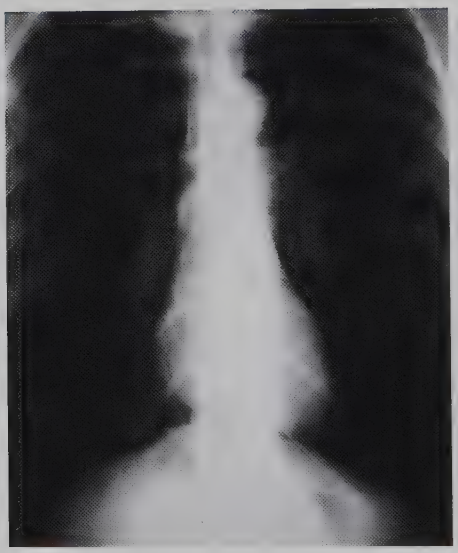
Clinical Pearls

1 ♦ The pigeon- or barrel-chest deformity is a sign of advanced cystic fibrosis (CF) pulmonary disease.

2 ♦ Almost all patients with CF have total opacification of their sinuses on computed tomography scan.

3 ♦ Bronchiectasis in CF is usually generalized.

4 ♦ End stage CF lung disease is evidenced by a "honeycomb" appearance on chest radiograph (parenchymal destruction and scarring).



56

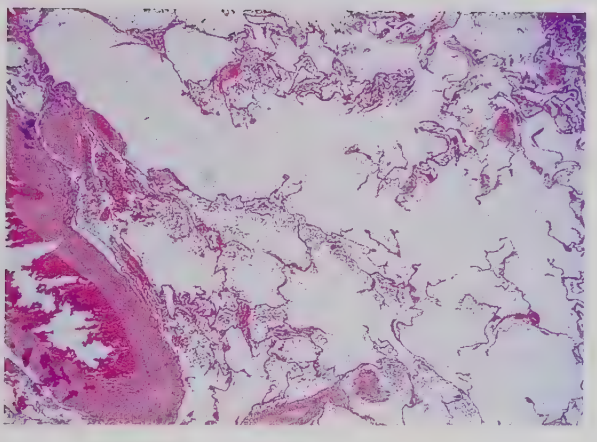
56 ♦ Mild centriacinar (centrilobular) emphysema that, in its initial phases, typically affects the respiratory bronchioles. There is mild hyperlucency but it is difficult to diagnose by chest radiograph at this stage. Centriacinar emphysema is characterized by dilatation and destruction of the respiratory bronchiole with the alveoli remaining largely intact.

57

57 ♦ Initial changes of centrilobular emphysema are much better demonstrated on computed tomography scan than on chest radiograph.

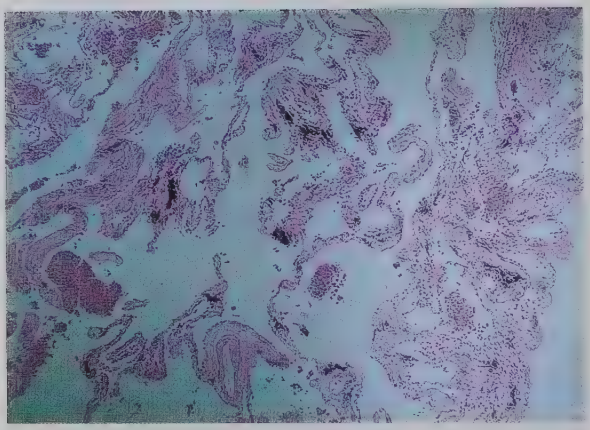
58

58 ♦ Emphysematous foci are scattered throughout the lung in association with the proximal segment of acinus as noted by their relationship to blood vessels.



59

59 ♦ Centriacinar emphysema is characterized by an enlarged airspace representing the destroyed respiratory bronchiole surrounded by normal parenchyma. The initial acinar location of the lesion can be recognized by a small muscular artery, which typically accompanies the respiratory bronchiole.



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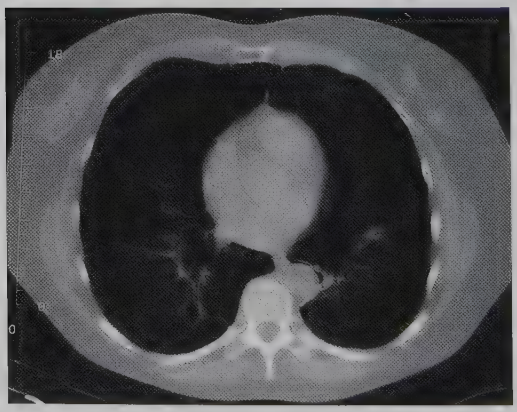

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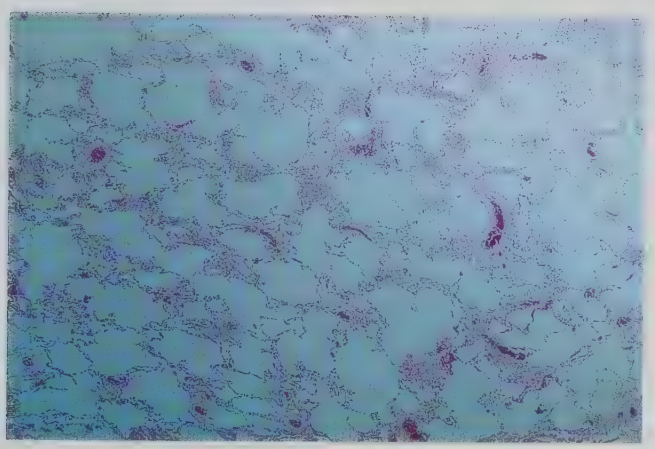
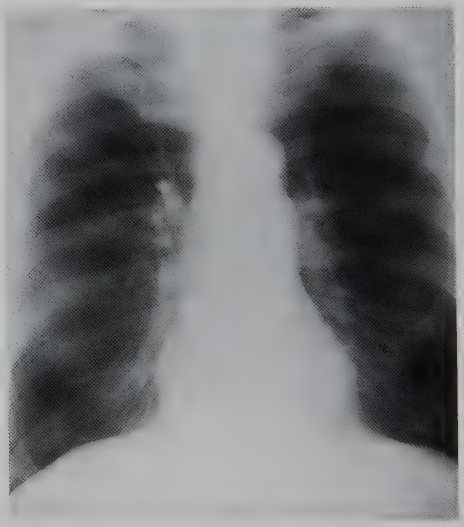


62

60 ♦ Anthracosis associated with centriacinar emphysema. Microscopic examination often reveals the presence of black pigment in association with centrilobular emphysema.

61 ♦ α_1-Antitrypsin deficiency. Panacinar emphysema is evident, particularly in the anterior portions of the lung. In contrast to centriacinar emphysema, panacinar emphysema is characterized by involvement of the distal segment of the acinus, including the alveolar duct and alveoli. This form of emphysema is most commonly seen in patients with α_1-antitrypsin deficiency.

62 ♦ Biopsy from a patient with early changes of panacinar emphysema. The alveoli are diffusely distended with disruption of several alveolar septa.

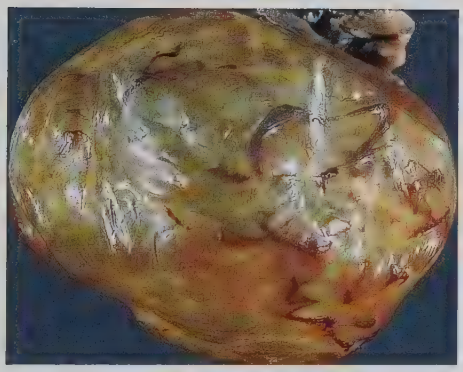


63

63 ♦ Several subpleural bullae are susceptible to spontaneous rupture, leading to pneumothorax.

64 ♦ Gross specimen demonstrating bullous emphysema.

65 ♦ Large bullae are susceptible to spontaneous rupture, leading to pneumothorax.



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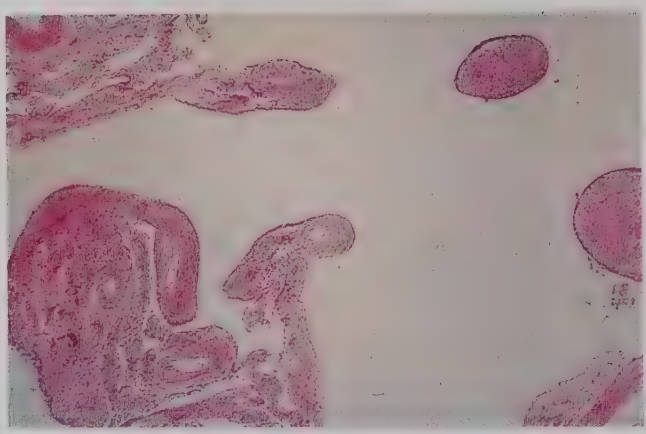
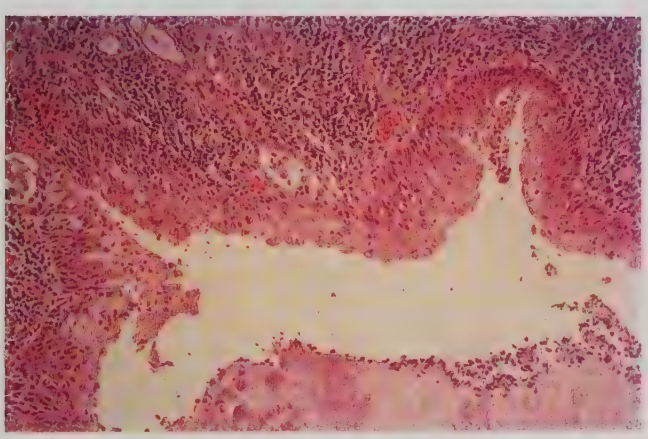


66

66 ♦ Bullous emphysema. Normal parenchyma is totally destroyed. Coarse fibrous septa are present in the area of bullae.

67-68 ♦ Chronic bronchitis. The bronchus is surrounded by a marked chronic inflammatory infiltrate, and the lumen is partially filled with mucus. Inflammatory cells infiltrate the bronchial epithelium.



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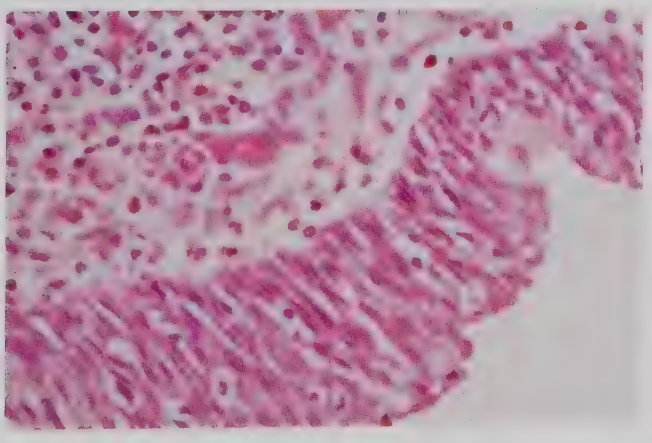

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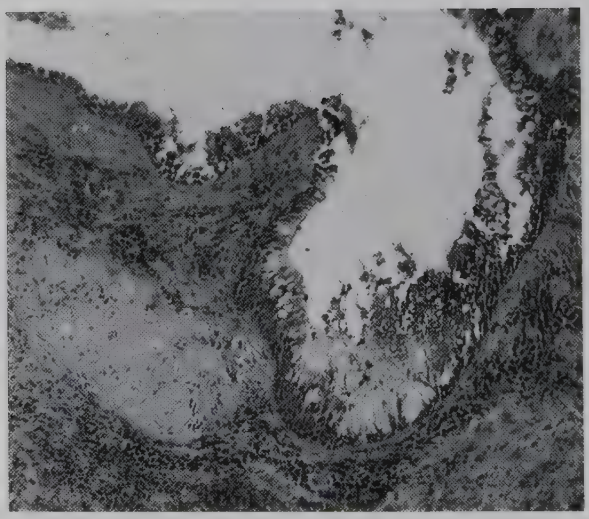
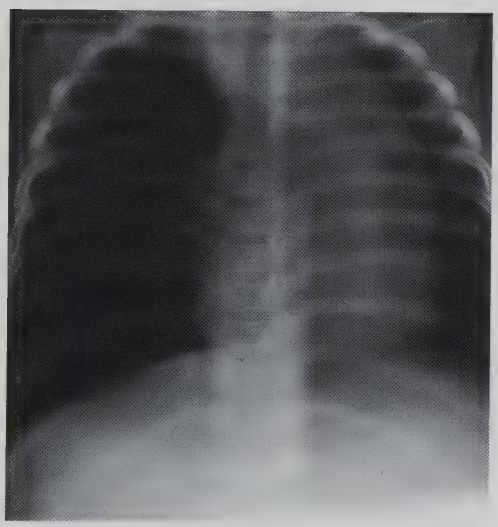


69

69 ♦ Hematoxylin and eosin-stained histologic section of adult bronchus demonstrating mucinous change and chronic inflammatory cell infiltrate consistent with chronic bronchitis.



70

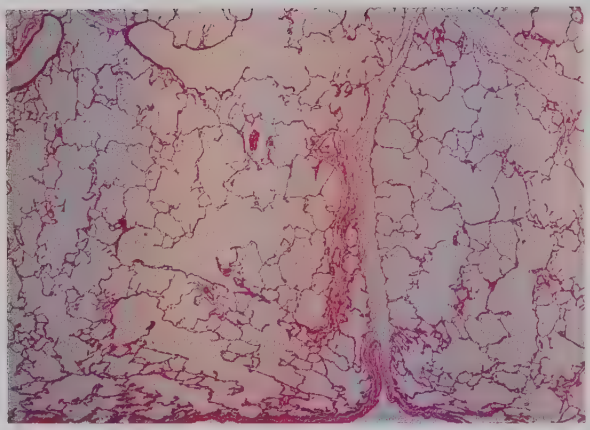
70-72 ♦ Congenital lobar emphysema. Radiographs demonstrate marked hyperlucency of the left lower lobe with mediastinal shift to the right, consistent with congenital lobar emphysema.

71

71 ♦ Congenital lobar emphysema. Lateral view of patient in 70.

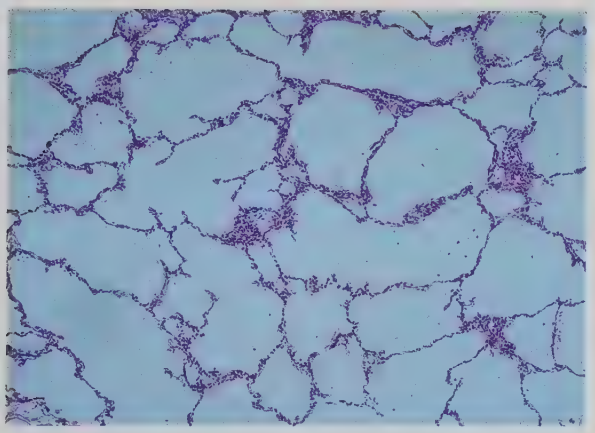
72

72 ♦ Congenital lobar emphysema. Marked hyperlucency of the left lower lobe.



73

73 ♦ Histology of congenital lobar emphysema. Marked distention of alveoli throughout the entire lobe.



74

74 ♦ Scattered, disrupted alveolar septa (drumsticks) are present.

Clinical Pearls

1 ♦ Panacinar emphysema has a predilection for the lower lobes.

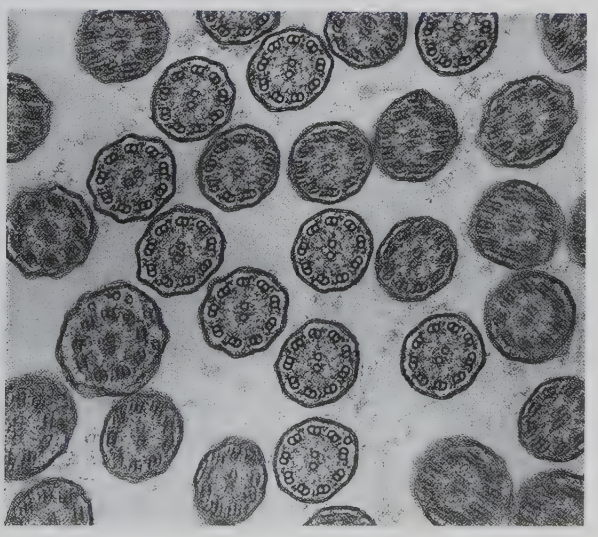
2 ♦ The hallmarks of centriacinar emphysema are destruction and dilatation of the respiratory bronchioles.

3 ♦ The hallmarks of panacinar emphysema are destruction of alveolar septa.

4 ♦ α_1-Antitrypsin deficiency leads to panacinar emphysema.

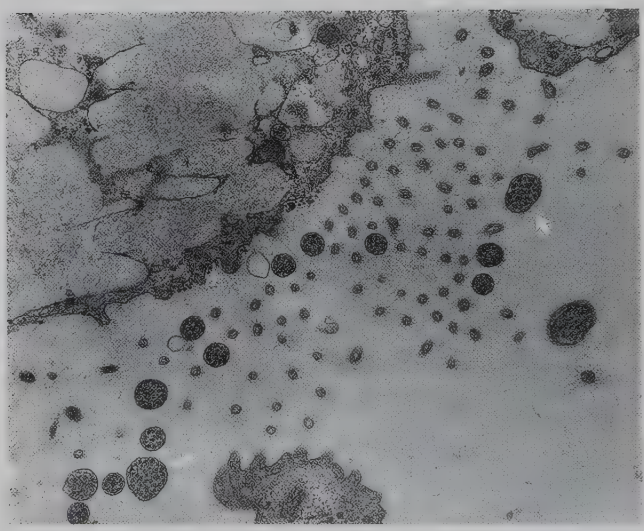
5 ♦ In bullous emphysema, the lung parenchyma is totally destroyed.

6 ♦ Congenital lobar emphysema most often involves the left upper lobe.



75

75 ♦ Primary ciliary dyskinesia. Cilia with a lack of inner dynein arms. The dynein arms contain most of the ATP-ase activity and are therefore important to ciliary motion.

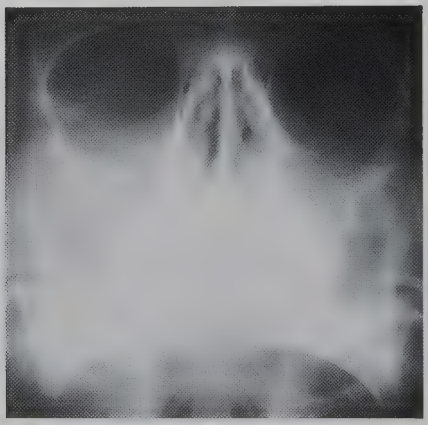


76

76 ♦ A number of secondary or acquired ciliary abnormalities such as the compound cilia shown may be found in respiratory cells from inflamed areas and should not be confused with primary ciliary dyskinesia.

77

77 ♦ Some patients with primary ciliary dyskinesia have situs inversus. When these patients have pansinusitis, in addition to bronchiectasis and situs inversus, they are diagnosed as having Kartagener's syndrome. Chest radiograph reveals dextrocardia with peribronchial thickening and subsegmental atelectasis involving both lower lobes.



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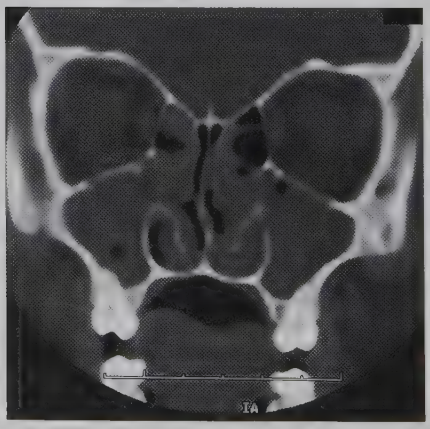

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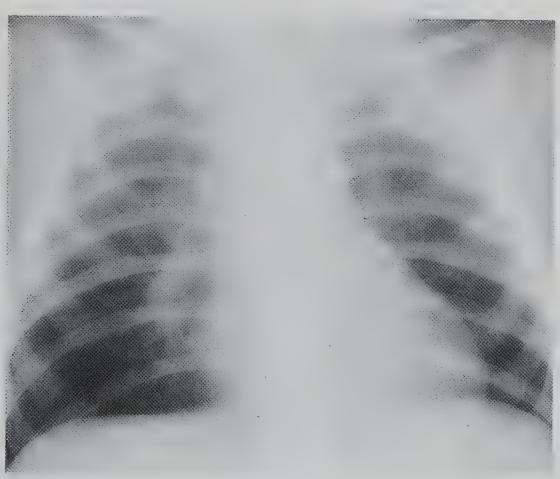


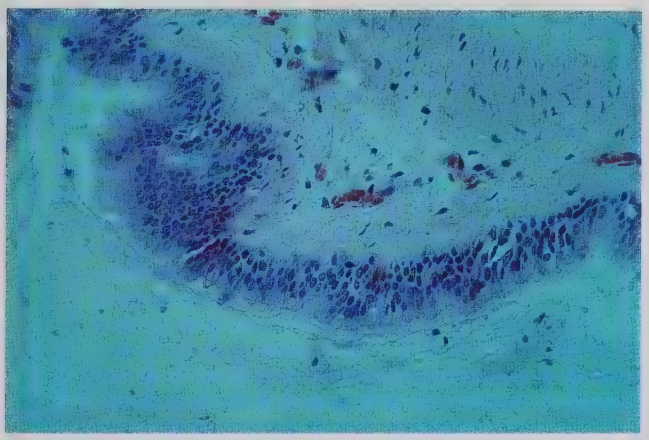
80

78-79 ♦ Opacification of all sinus cavities is a common radiographic feature of primary ciliary dyskinesia. The clinical severity varies among patients, with most patients complaining of chronic nasal obstruction, postnasal drip, anosmia, halitosis, and facial pain.

80-82 ♦ Bronchogenic cysts are abnormal structures emanating from the embryonic tracheobronchial tree. An intrapulmonary location may occasionally be present. The plain radiograph may not be diagnostic, but the barium esophagogram may show indentation in the esophagus.

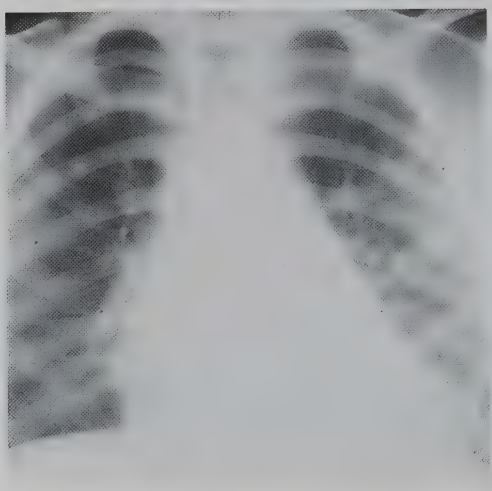
81

82



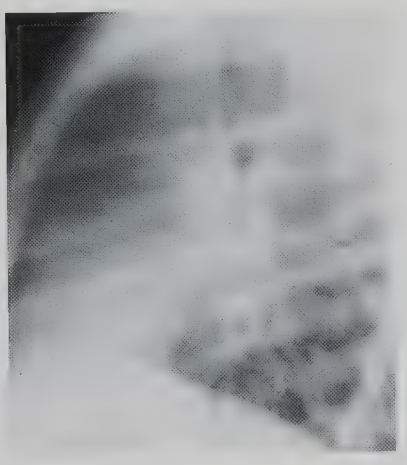
83

83 ♦ Histologically, the bronchogenic cyst wall contains mucous glands, smooth muscle, and cartilage. The cyst lumen is usually lined by secretory, ciliated, columnar, or cuboidal epithelium, which may have foci of squamous metaplasia. The cyst fluid is mucoid or clear.



84

84-86 ♦ Bronchiectasis refers to dilatation of bronchi and can be primary or secondary. Chest radiographic findings may be nonspecific and may show some increased peribronchial thickening and increased markings. Bronchogram shows dilatation of bronchi and is diagnostic.



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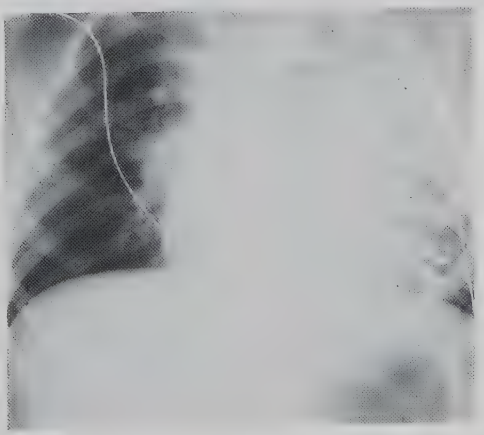

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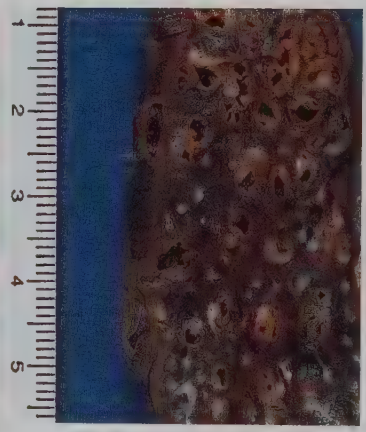

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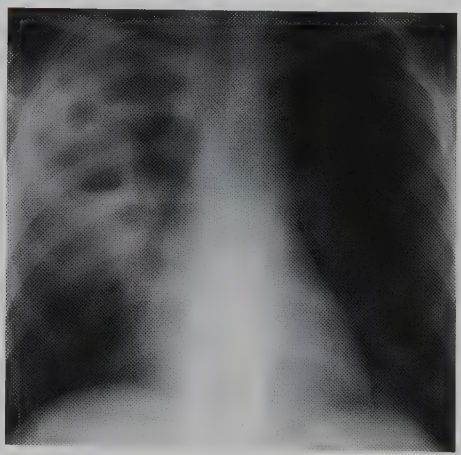


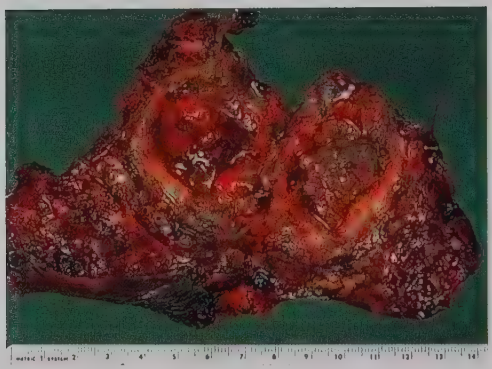
89

90

87 ♦ Cut surface of a lung with bronchiectasis reveals numerous dilated bronchi.

88 ♦ Formalin-fixed section of lung from a child with a form of congenital bronchiectasis known as Williams-Campbell syndrome. Children with this syndrome develop bronchiectasis due to abnormal bronchial cartilage.

89-90 ♦ Multiple abscesses in the right upper lobe of an 11-year-old boy who presented with a persistent cough. Note the air-fluid levels in some of the abscess cavities.



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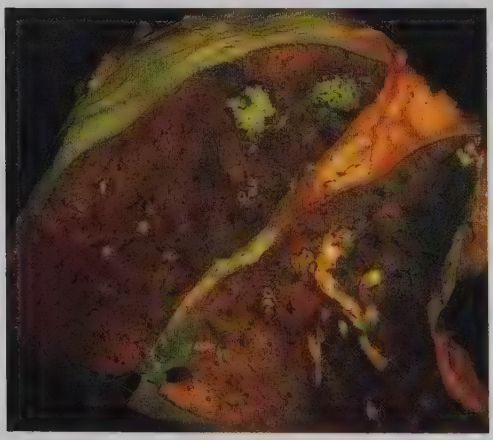

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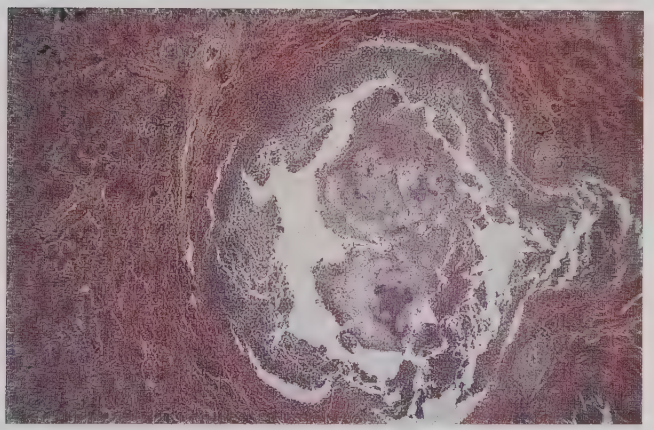

93

91 ♦ A resected lung segment with a large abscess cavity.

92 ♦ Autopsy specimen from a debilitated patient with multiple diseases reveals multiple abscess cavities throughout the lungs. Postmortem cultures grew *Staphylococcus aureus.*

93 ♦ Lung abscess is characterized by a central area of necrosis and a collection of neutrophils. The abscess cavity is surrounded by a fibrous wall and chronic inflammation.

Clinical Pearls

1 ♦ Lung abscess size ranges from a few to many centimeters in diameter.

2 ♦ Kartagener's syndrome triad includes bronchiectasis, dextrocardia, and sinusitis.

3 ♦ The barium esophagogram shows anterior-lateral indentation of the esophagus when bronchogenic cysts are present.

4 ♦ When bronchiectasis is present, the chest radiograph shows peribronchial thickening and increased bronchovascular markings.

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